

WHAT IS CLAIMED IS:

1                    1.        A system for removing an obstruction from a blood vessel, comprising:  
2                    a catheter having a lumen;  
3                    an expandable capture element which is contained within the lumen of the  
4 catheter, the capture element being slidable within the lumen of the catheter between a  
5 collapsed position contained within the lumen and an expanded position in which the capture  
6 element is positioned outside the lumen; and  
7                    an obstruction engaging device having a filament, the filament being movable  
8 from a collapsed position to an expanded position, the obstruction engaging element passing  
9 through the catheter.

1                    2.        The system of claim 1, wherein:  
2                    the expandable capture element is naturally biased toward the expanded  
3 position when positioned outside the lumen.

1                    3.        The system of claim 3, wherein:  
2                    the expandable capture element has a support structure with a flexible cover  
3 attached to the support structure.

1                    4.        The system of claim 3, wherein:  
2                    the self-expanding support structure has a closed loop having integrally formed  
3 hinges.

1                    5.        The system of claim 4, wherein:  
2                    the hinges are V-shaped interconnecting elements.

1                    6.        The system of claim 3, wherein:  
2                    the support structure has a plurality of longitudinal struts extending from the  
3 loop.

1                    7.        The system of claim 1, wherein:  
2                    the capture element has an expandable loop at the distal end.

1                    8.        The system of claim 7, wherein:

2 the loop is formed by an eyelet with a control arm extending through the  
3 eyelet.

1 9. The system of claim 1, wherein:  
2 the capture element has a flexible cover, the cover having a length which is at  
3 least three times an expanded diameter of the capture element.

1 10. The system of claim 9, wherein:  
2 the length of the cover is at least five times the expanded diameter of the  
3 capture element.

1 11. The system of claim 1, wherein:  
2 the engaging device has 1-4 filaments.

1 12. A method of removing an obstruction from a blood vessel comprising  
2 the steps of:  
3 providing a catheter, an obstruction engaging device and an expandable  
4 capture element, the capture element being contained within a lumen of the catheter in a  
5 collapsed position, the capture element moving to an expanded position when positioned  
6 outside the lumen, the obstruction engaging device having a filament which is movable from  
7 a collapsed position to an expanded position;  
8 introducing the catheter into a blood vessel of a patient;  
9 engaging an obstruction with the filament;  
10 expanding the capture element; and  
11 moving the obstruction into the capture element with the engaging device after  
12 the engaging and expanding steps.

1 13. The method of claim 12, wherein:  
2 engaging step is carried out with the filament penetrating and ensnaring the  
3 obstruction.

1 14. The method of claim 12, wherein:  
2 the expanding step is carried out with the capture element being naturally  
3 biased toward the expanded position with a self-expanding support structure.

1           15.    The method of claim 14, wherein:  
2           the providing step is carried out with a flexible material attached to the support  
3   structure.

1           16.    The method of claim 15, wherein:  
2           the providing step is carried out with the self-expanding support structure  
3   having a closed loop.

1           17.    The method of claim 15, wherein:  
2           the providing step is carried out with the loop being integrally formed.

1           18.    The method of claim 15, wherein:  
2           the providing step is carried out with the support structure has a plurality of  
3   longitudinal struts.

1           19.    The method of claim 18, wherein:  
2           the providing step is carried out with the loop being formed by a number of  
3   integrally formed hinges.

1           20.    The method of claim 19, wherein:  
2           the providing step is carried out with the hinges being V-shaped elements.

1           21.    The method of claim 12, wherein:  
2           the obstruction engaging element has 1-4 filaments.

1           22.    A system for removing an obstruction from a blood vessel, comprising:  
2           a catheter having a lumen;  
3           an expandable capture element contained within the lumen of the catheter, the  
4   capture element being in a collapsed position when contained within the lumen and being in  
5   an expanded position when positioned outside the lumen, the expandable capture element  
6   having a support structure forming a closed loop having a plurality of integrally formed  
7   hinges; and  
8           an obstruction engaging device which extends through the expandable capture  
9   element, the engaging device having a collapsed shape and an expanded shape.

1                   23.     The system of claim 22, wherein:  
2                   the capture element has a flexible cover attached to the support structure, the  
3 cover having a distal end which is positioned at the loop so that the loop opens the distal end  
4 of the cover.

1                   24.     The system of claim 22, wherein:  
2                   the support structure has a plurality of longitudinal struts which extend  
3 proximally from the loop.

1                   25.     The system of claim 24, wherein:  
2                   the struts do not intersect and form a form a conical shape when the capture  
3 element is in the expanded.

1                   26.     The system of claim 22, wherein:  
2                   the loop has integrally formed hinges.

1                   27.     The system of claim 26, wherein:  
2                   the hinges are formed by V-shaped elements.

1                   28.     The system of claim 22, wherein:  
2                   the obstruction engaging device has a filament configured to penetrate and  
3 engage an obstruction.

1                   29.     A system for removing an obstruction from a blood vessel, comprising:  
2                   a catheter having a lumen;  
3                   an expandable capture element which is contained within the lumen of the  
4 catheter, the capture element being slidable within the lumen of the catheter, the capture  
5 element having an actuator for manually expanding and contracting the capture element; and  
6                   an obstruction engaging device which passes through the capture element.

1                   30.     The system of claim 29, wherein:  
2                   the obstruction engaging devices includes a filament for engaging the  
3 obstruction.

1                   31.     The system of claim 29, wherein:

2 the actuator has a control arm and a stable arm. the control arm being  
3 manipulated to expand and collapse the capture element.

1 32. The system of claim 29, wherein:  
2 the actuator has a loop and a control arm which is manipulated to open and  
3 close the loop.

1 33. The system of claim 29, wherein:  
2 the capture element everts when moving outside the lumen.

1 34. The system of claim 29, wherein:  
2 the actuator includes a tube and a wire extending through the tube.

1 35. The system of claim 29, wherein:  
2 the actuator includes at least two wires.

1 36. The system of claim 35, wherein:  
2 the actuator includes first and second stabilizing wires and at least one  
3 actuating wire.

1 37. A catheter for capturing an obstruction, comprising:  
2 a catheter having a lumen;  
3 a capture element positioned in the lumen of the catheter, the capture element  
4 being expandable, the capture element having an expandable support structure and a cover  
5 attached to the support structure, the cover having a length which is at least three times a  
6 diameter of the support structure in the expanded position.

1 38. The catheter of claim 37, wherein:  
2 the cover has a length which is at least five times a diameter of the support  
3 structure in the expanded position.

1 39. A device for removing an obstruction from a blood vessel, comprising:  
2 an expandable loop which is movable from a collapsed position to an  
3 expanded position;

4                   a cover coupled to the loop, the distal end of the cover being moving from a  
5 closed position to an open position when the loop moves from the collapsed to expanded  
6 positions; and

7                   a tube having an actuator extending therethrough, the actuator being coupled  
8 to the loop so that relative movement between the tube and the actuator causes the loop to  
9 move between the expanded and collapsed positions.

1                   40.     The device of claim 39, wherein:  
2                   the tube is positioned outside the cover.

1                   41.     The device of claim 39, further comprising:  
2                   a catheter passing through the cover; and  
3                   an obstruction engaging device passing through the catheter.

1                   42.     A device for removing an obstruction from a blood vessel, comprising:  
2                   a tube;  
3                   a support structure movable between a collapsed position and an expanded  
4 position, the support structure extending through the tube and being naturally biased toward  
5 the expanded position, wherein the support structure expands when moved out of the distal  
6 end of the tube and is in the collapsed position when contained within the tube, the support  
7 structure being bowed outward;  
8                   a cover coupled to the structure, the cover moving from a closed position to an  
9 open position when the loop moves from the collapsed position to the expanded position.